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CUCUMBER GROWING



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TABLE OR SLICING CUCUMBERS are grown for the market in 29 States, but the main carlot movements originate in 16 States.

The markets are now well supplied, and the present outlook for table-cucumber consumption in the United States does not warrant any great expansion of acreage.

Average gross returns from field-grown table cucumbers during the period from 1928 to 1934 were less than \$100 an acre; the average production cost was approximately \$80 an acre.

The forcing of early spring cucumbers in cold-frames has become a highly specialized industry, mainly in the Norfolk, Va., district.

The market requirements are for cucumbers that are fresh, crisp, of medium size, dark green in color, clean, and uniformly graded.

This bulletin contains cultural directions for growing table or slicing cucumbers in coldframes and as a field crop. For information on the production of cucumbers in greenhouses the reader is referred to Farmers' Bulletin 1320 and for growing cucumbers for pickling, to Farmers' Bulletin 1620.

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CUCUMBER GROWING

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REVIEW OF THE INDUSTRY

CUCUMBERS are included among the 20 important commercial truck crops that are shipped to the markets of the United States in large quantities. The area planted to cucumbers for table purposes in 1934, as reported by the Bureau of Agricultural Economics, was 41,990 acres, the crop produced being valued at \$2,987,800. This acreage is exclusive of approximately 80,000 acres of cucumbers grown for pickles and also of the crop produced in greenhouses. This bulletin deals only with the production of table or slicing cucumbers as a field crop and those grown in coldframes during the early part of the season.

Fresh or table cucumbers are grown for carlot shipment in 29 States and in large quantities in 16 of them. Florida was the largest shipper in 1934, having shipped 737 of a total of 3,966 cars shipped by the entire cucumber-producing territory. The shipment of cucumbers to the larger markets is divided into three seasonal periods—early, intermediate, and late. The early-shipping section includes Alabama, Florida, Georgia, Louisiana, South Carolina, Texas (southern portion), and Virginia (sash grown). The intermediate territory includes North Carolina, Virginia (field grown), Arkansas, Delaware, southern Illinois, Maryland, and New Jersey, although New Jersey might be considered in both the intermediate and the late territory. New York is the outstanding State in the production of late cucumbers, although New Jersey, Maryland, Illinois, Delaware, Ohio, and Indiana are shipping at the same time.

Florida ships during two seasons of the year, the first, including October, November, and December; the second, April, May, and June, May being the heaviest shipping period for this State. Shipments from South Carolina, North Carolina, Louisiana, Virginia, and the southern part of California follow or overlap those from Florida.

For table or slicing cucumbers as a salad vegetable there is a fairly good demand, especially during the spring and early summer months. Although they do not form one of the major vegetable crops grown in the United States, their production is a source of considerable farm income. The growing of high-grade table cucumbers is rather difficult, owing mainly to the prevalence of insects and diseases which must be overcome by spraying and by other special methods. Yields and prices have declined during the 5-year period 1930-34, and the production of cucumbers as a field crop has been only reasonably profitable. There were intervals in this period during which the markets were temporarily overstocked and prices therefore were low.

The present outlook for table-cucumber consumption in the United States does not warrant any great expansion of acreage, and there is need for more intensive culture and the production of higher-grade table stock. This is particularly true of the sections where the crop is grown in the field, as the frame industry leaves little to be desired in the way of quality of product or intensity of cultural practices. It is estimated that there are about 150 acres in the Norfolk district devoted to the growing of cucumbers under sash. This industry has developed since about 1906, and on the whole has been fairly profitable. At present, however, production costs are so heavy as to render the sash growing of cucumbers rather hazardous; in fact, only the best growers claim to be making any money. Gross returns from an acre of frames range from \$1,000 to \$2,000 for the cucumber crop alone, but high production costs very greatly offset these large returns.

The growing of cucumbers under sash is essentially a modification of intensive field culture by which the hazards of early planting are largely eliminated through the use of greenhouses for starting the plants and by growing the crop to an advanced stage in coldframes. This system has the advantage of greatly lengthening the season, considerable quantities of cucumbers being marketed before the outdoor crop is much more than planted. In some instances the frame-grown plants continue to produce until midsummer and after the field crop has been plowed under.

SOIL AND FERTILIZERS

Cucumbers can be grown on almost any good soil. The commercial crop, however, is produced largely on the sandy loams of the Gulf coast and Atlantic coast regions. A soil consisting of from 14 to 18 inches of dark sandy loam overlying a close sand or medium clay subsoil is ideal, especially if the natural water level of the area is within 8 or 10 feet of the surface, thus insuring an ample supply of subsoil moisture. The intensive hotbed and coldframe crop of the Norfolk district is produced on highly fertilized sandy loam. In Florida and elsewhere in the Atlantic and Gulf coast regions the field crop is grown by the aid of considerable quantities of commercial fertilizers. In order to avoid diseases, it is essential that cucumbers be grown in long-period rotations and on new land or on that which has not been used for any of the vine crops for at least the 3 or 4 preceding years. Good drainage, together with moisture-holding power, is essential in soils on which cucumbers are to be grown.

Even where considerable manure is available, one or more of the soil-improvement crops should be included in the rotation and these

turned under to enrich the soil and add humus. Where a winter cover crop is grown on the land it will be necessary to turn it under at least 2 or 3 weeks in advance of planting. Where only a limited quantity of manure is available, it can be used to best advantage if it is placed in furrows underneath the rows, or if the plants are to be grown in hills, the manure can be mixed with the soil composing the hills. In field culture the manure is sometimes applied by means of a manure spreader in a narrow strip where the rows are to be located. In the Wilmington, N. C., district, cucumbers follow early spring lettuce, the cucumber crop in turn being followed by soil-improvement crops. In Florida, velvetbeans are largely used as a soil-improvement crop.

The frame-cucumber growers of the Norfolk-Portsmouth, Va., district usually grow a crop of soybeans, sorghum, rye, or cowpeas on their land during the late summer and turn these crops under for soil improvement. They also apply 70 to 100 tons of manure to the acre



FIGURE 1.—Fertilizing cucumber beds in the Norfolk, Va., district during early December.

each year. The manure is first thoroughly composted, and a portion of it spread upon the beds during the early winter, as shown in figure 1. A week or two in advance of setting the cucumbers the remainder of the manure is placed in a furrow through the middle of the beds and completely mixed with the soil by means of a one-horse cultivator before the ground is rebudded for planting.

Commercial fertilizers containing 4 to 5 percent of nitrogen, 8 to 10 percent of phosphoric acid, and 4 to 5 percent of potash are applied broadcast at the rate of 1 ton to the acre by most southern cucumber growers. In outdoor culture the entire 2,000 pounds is sometimes applied before planting; in other cases only about 1,200 pounds is applied in advance and the remainder is used in the form of side dressings during the growing period. In frame culture about 2 tons of high-grade commercial fertilizers are applied during the season, one-half of which is worked into the soil in advance of planting the crop, and the remainder is used as side dressings during the growing

season. As a rule, a crop of early beets is grown on the land in the spaces between the cucumber beds, and additional fertilizers are applied to the beets.

Nitrate of soda is frequently used as a stimulant for both the frame-grown and the field-grown cucumber crops during the growing season, applications of 100 to 200 pounds per acre being made by turning back the vines and drilling or broadcasting the nitrate along the rows. In some cases a small furrow is opened, into which the nitrate is scattered; the furrow is then turned back in place. The frame-cucumber growers of the Norfolk district frequently dissolve the nitrate of soda in the tanks from which water is drawn for watering the plants in the beds. The nitrate is placed in the tank and the water stirred until all the nitrate is dissolved and uniformly mixed. The plants are then given a moderate watering with this solution, which greatly stimulates their growth. The nitrate should be used at a rate not exceeding 50 pounds to each 7,000 or 8,000 gallons of irrigation water. Complete fertilizers containing as much as 7 to 10 percent of readily available nitrogen are frequently used for side dressings, on both the field and the frame cucumber crops, instead of nitrate of soda or other form of readily available nitrogen, without the addition of phosphoric acid and potash. When dissolved in the irrigation water, nitrate of soda seems to give the quickest response, but for permanent results many growers prefer to use a complete fertilizer.

The fertilizer requirements of cucumbers depend to a considerable degree upon the supply of organic matter in the soil and especially on the extent to which this matter is derived from animal manures. In southern field culture, where little manure is available, a combination of soil-improvement crops and commercial fertilizers is relied upon to meet the plant-food requirements of the cucumber crop. In view of the fact that high-grade fertilizer ranges in price from \$30 to \$40 a ton according to location and grade, which alone constitutes an important item in cucumber production costs, and that the average returns from field-grown cucumbers are about \$100 an acre, the initial expenditure of \$30 to \$40 for fertilizer greatly reduces the ultimate profits. Gross returns from the specialized frame culture of cucumbers are of course much higher, thus justifying a greater expenditure for fertilizers.

SOIL PREPARATION

Soils of the character on which cucumbers are usually grown are relatively easy to prepare. The more successful growers disk and harrow the land several times after plowing, in order that all the manure and fertilizers may be thoroughly mixed with the soil. The Norfolk frame-cucumber growers plow their land in the late fall, apply a heavy coating of manure, and disk the soil several times to work in the manure.

As the main considerations are earliness, quality, and a fairly long picking season, thorough preparation of the soil is essential, especially where production costs are high. The methods of soil preparation depend upon locality; for example, throughout the South Atlantic and Gulf Coast States the land is bedded, the height depending upon drainage conditions, and the seed is planted on top of the bed. In other sections the land is plowed and harrowed broadcast, the rows are marked off, and the seed is planted on the level or in a slight

furrow. In sections where irrigation is practiced, the land is plowed in beds with irrigation furrows between, and the seed is planted just above the water level of the furrow.

Where a soil-improvement crop is grown during the late summer, it is plowed under before it is killed by frost. The land is then disked at intervals until November or December, when the manure is applied and the land again disked two or three times. The final preparation of the land begins about a month in advance of planting. In Florida soil preparation proceeds at any time during the late fall and early

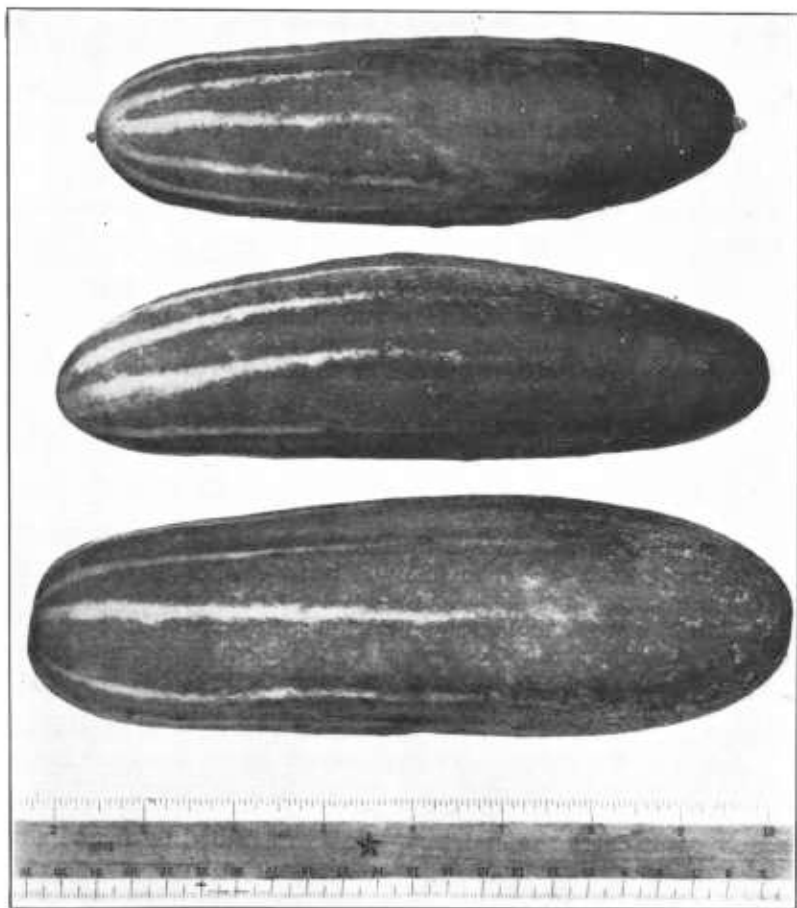


FIGURE 2.—Typical cucumbers of the white-spined type. The large specimen is overripe; the two smaller ones are about the right size for marketing.

winter. The beds are thrown up somewhat higher than is required for planting and are then harrowed or dragged to a lower level, in many cases almost flat, before they are planted.

VARIETIES

The white-spined type is most commonly grown in field culture (fig. 2). The newest strains are characterized by their dark-green color and the ability to retain this color during shipment. Probably

the most popular in this group are Stays Green and Black Diamond. They are early and productive and range from 6 to 8 inches in length and from $2\frac{1}{4}$ to $2\frac{1}{2}$ inches in diameter at harvest, and are blocky or cylindrical in shape. Early Fortune, another popular white-spined shipping variety, is slightly longer and later maturing than the above-mentioned varieties and tapers slightly at both ends. Growers desiring a cucumber slightly longer than Early Fortune should try Clark Special, Woodruff Hybrid, or Davis Perfect. Varieties longer than these are rarely successful when grown in the field. Long Green is the only black-spined variety that is grown to any extent for slicing purposes.

SEED SUPPLY

Too much stress cannot be placed on the importance of good seed. In view of the fact that less than 2 pounds of seed is required to plant an acre, the grower may well afford to pay a reasonably high price provided he is getting the quality represented. Certain seed houses are now meeting the demand for superior seed, in many cases treating the seed with organic mercury compounds to reduce the possibility of carrying to the fields any of the so-called seed-borne diseases. Cucumber seed retains its vitality from 3 to 5 years if kept under proper conditions of low moisture and uniform temperature. Reasonably fresh seed, however, is recommended. Many of the most successful cucumber growers have their own strain and save their seed from specially selected cucumbers. It is essential, however, that no cucumbers of inferior strain or of another variety be grown nearby, as bees are certain to carry the pollen and cause mixtures.

PLANTING THE FIELD CROP

Because cucumbers are susceptible to frost injury, planting in the field must necessarily be delayed until danger of frost is past. In some sections paper caps or covers are being used to protect the young plants, a week to 10 days being gained thereby in earliness of planting. As a general rule, however, it is not safe to put the seed in the ground until the soil is fairly warm. Some growers follow the practice of planting three lots of seed, the first being placed in the ground about 10 days or 2 weeks before the date of the average last killing frost for the locality, the second about a week later, and the third after both the first and second lots have appeared above the ground. If the first planting is not lost, it gives an extra-early crop. In some cases the first planting will be killed by frost and the second will come through the ground after the frost and form the basis for the crop. In a few instances both the first and second plantings are killed, in which case the third planting must be relied upon for a stand.

The final preparation of the soil usually consists of smooth harrowing or dragging just before planting the seed. In case of rain between the time of applying the fertilizer and planting, the land is given a light harrowing or dragging ahead of the planter. Many growers prefer to apply the fertilizer during this final preparation, in which case the work is done directly ahead of the planters.

Where the cucumbers are planted in hills the land is usually marked in both directions and the seed planted in the intersections. If the planting is in one direction only the land is marked one way and the

planter run in the mark. Frequently a marker is attached to the side of the planter and the land marked and planted at one operation. Horse-drawn planters are used wherever the acreage is sufficiently large to warrant this, or an ordinary hand planter with a wheel in front is used. Care must be taken that the average planting machine does not put in too much seed.

Planting distances vary with the locality. Where the cucumbers are grown in hills, the hills are usually spaced 6 by 6 or 6 by 8 feet apart. When the planting is in rows, the rows are placed 4 to 8 feet apart and the plants thinned so that they stand 2 to 3 feet apart in the row. Wider spacing of rows and thinning to a single plant every 6 or 7 feet in the row has been found under most conditions to give better yields than are obtained by closer spacing. Cultivating, spraying, and picking are all made easier by wide spacing, and there is the suggestion that both insects and diseases may not be so troublesome where the vines do not mat together. Where the crop is grown in beds, the beds are generally 4 to 6 feet in width, the row being directly on top. In irrigated sections the row is placed on the south side of the bed and on the edge of the irrigation furrow, the seed being planted in hills. After the beds are made and the irrigation furrows opened, the water is admitted to the furrows to establish a level which serves as a guide in planting. The water is then shut off and the seeds are planted in hills just above the water level. A second irrigation is frequently given to supply the moisture necessary to sprout the seeds.

Where cucumbers are planted in checks or hills, 9 or 12 seeds are placed in each hill by hand and covered about an inch deep, but if planted in rows the seed is scattered thinly along the entire row. In planting in beds a slight furrow is opened through the middle of the bed and the seed planted in this furrow, or the seed drill is run in the middle of the bed. Cucumbers require thinning, as a rule four to six plants being left in each hill at the first thinning, these being reduced to two or three plants after they have become well established. Where the cucumbers are planted in a continuous row, the initial thinning can be done with a hoe at the time of the first hand-hoeing, but the final thinning to a proper stand should be done by hand after the plants become well established.

PROTECTION FROM COLD IN THE FIELD

Paper caps are sometimes used to protect the hills of cucumbers during the first week or 10 days in the field. These caps are put on as soon as the seed is planted and are kept over the young plants until danger of severe cold is over. Paper caps are not adapted for the protection of plants after they attain any considerable size.

In Florida the growers frequently use a protection consisting of two cypress boards nailed together in the form of a V-shaped trough. These troughs are turned over the rows of cucumbers at night and during extremely cold days, but in the daytime are placed to one side of the row, where they serve as a windbreak for the plants (fig. 3). In order to derive the greatest benefit from wind protection, the rows are run at right angles to the direction of the prevailing winds. The troughs are placed during the day so that the young plants will gain the greatest benefit from the sunshine.

Small boxes covered by panes of glass are also used as protectors to some extent. The bulk of the field cucumber crop, however, is grown without special protection.



FIGURE 3.—Wooden troughs used for protecting young cucumber plants in Florida.

PLANTING THE FRAME CROP

Cucumbers grown in frames are started in greenhouses (fig. 4) and transplanted to the frames, earliness being the main objective.



FIGURE 4.—Type of greenhouse used for growing early cucumber plants for setting in coldframes. Note in the foreground the stack of flowerpots in which the plants are grown.

In the Norfolk district the seed is sown about February 24 or 25 in a small bed in a greenhouse heated by pipes buried in the soil at intervals of 12 or 14 inches and about a foot below the surface. Hot water from the greenhouse boiler circulates through these pipes, raising the

temperature of the soil to about 80° or 82° F. The soil is warmed and properly moistened several days in advance of planting the seed. On the appointed date, usually 3 days before March 1, the seeds are sown in drills in this heated bed, covered lightly, and kept properly moistened. In 3 or 4 days the seedlings are ready for transplanting. They are then carefully lifted and placed in 5-inch or 6-inch flowerpots filled with excellent and well-enriched potting soil, seven to nine plants being set in each pot. The pots are then placed on the greenhouse benches, and a temperature of 65° to 80° is maintained in the house, with proper ventilation, during a period of about 4 weeks. In the meantime the plants are thinned, first to four or five in a pot and later to three. At the end of 4 weeks under proper management the plants will have formed about three true leaves, as shown in figure 5, and will begin to crowd, making it necessary to separate the pots 2 to 3 inches on the greenhouse benches. Contrary to the general belief that cucumbers cannot be readily transplanted, the sash growers of the Norfolk district have been following this practice successfully for many years.

During the time that the plants are being grown in the greenhouse the coldframes are prepared for the transfer of the plants to them. The frames consist of two parallel lines of boards, a 1- by 12-inch board at the north side and a 1- by 6-inch board at the south side, set on edge and fastened to stakes. The sash simply rests upon these boards, no crosspieces being provided. In preparing the beds for planting, a deep, broad furrow is opened through the center and partly filled with well-rotted manure. The manure is then mixed with the soil in the bottom of the furrow, the soil turned back over the manure, and the surface harrowed, leaving a slight depression or broad furrow through the center of the bed. The sash are then placed on the frames and the beds allowed to become warm from the heat of the sun. In setting the plants in the beds the pots containing them are taken to the frame yard and the ball of earth carefully jarred loose from the pot and set in the bed, one hill directly under the center of each sash. As the plants are set they are watered, the sash replaced, and careful attention given to the ventilation, also to protecting the plants from cold drafts and severe wind until they become well established.



FIGURE 5.—Greenhouse-grown cucumber plants ready to be set in coldframes.

MANAGEMENT OF FRAMES

Temperature control of the beds is very important, and although a maximum of 85° F. is permissible, care must be taken to provide ventilation to prevent overheating. Ventilation is obtained by propping up the sash, always on the side opposite the wind, 4, 6, or 12 inches as required, by means of small notched boards, as shown in figure 6. The passing of a small cloud on a bright but chilly day will frequently reduce the temperature in the beds 10° to 20° and

require that the sash be lowered, but with the return of the sunshine the sash should again be raised. The more successful sash growers keep a man stationed on each acre of sash during daylight hours, his main duty being to watch the thermometers in the beds and to regulate the temperature. Night temperatures are controlled to considerable extent by closing the beds early in the evening and, in extreme cases, placing a thin layer of straw or marsh hay over the glass.

WATERING IN FRAMES

Watering frame-grown cucumbers is almost as important as temperature control, but its frequency depends upon weather conditions. If the weather is cloudy, very little watering will be required; on the other hand, if the weather is bright and there is considerable wind, watering will be necessary two or three times a week. Water is applied with a 1-inch hose, usually in the morning when the tem-

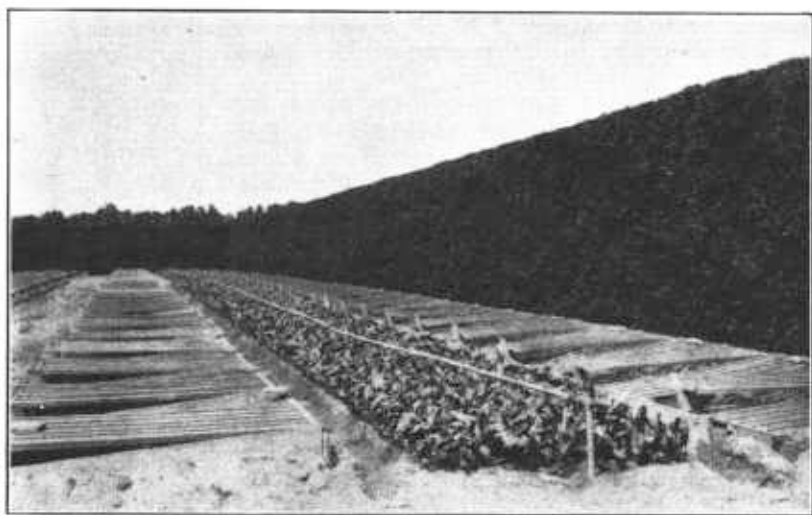


FIGURE 6.—Cucumber frames with a crop of early beets in the spaces between the frames. Originally over the beets, these frames were simply moved over for the cucumbers. The method of ventilating the frames is also shown.

perature is rising, a man and a boy working together, the boy going ahead raising the sash and propping each about a foot high, while the man does the watering. The beds are then closed immediately unless the temperature is such as to require their being left open. The quantity of water will depend upon the condition of the soil. The water is applied in a soft stream from a hose without a nozzle, the stream sometimes being spread by holding the thumb or finger lightly over the end of the hose. The precaution should always be taken to apply the water to the soil without greatly washing or injuring the plants. After the removal of the sash and frames, water is applied by means of lines of sprinkler pipe supported on stakes about 24 inches above the ground.

CULTIVATION IN FRAMES

Cucumbers grown in frames are cultivated and fed with fertilizer from the very start. The plants are hand-hoed about once a week until the vines completely fill the 6-foot beds. After all danger of cold weather is past the sash are removed and stored in sheds, and the board sides of the frames are taken away. The 6-inch board at the front of the frame is first removed, the 12-inch board being left at the rear for protection. Later, this is also taken away, the vines are turned slightly, and the soil is cultivated under them. The vines are again spread and allowed to occupy the entire area between the beds, as shown in figure 7. Large quantities of cucumbers are often marketed from the frames before the removal of the sash, but the heaviest pickings occur about the middle of June, after both the sash and the frames have been removed.

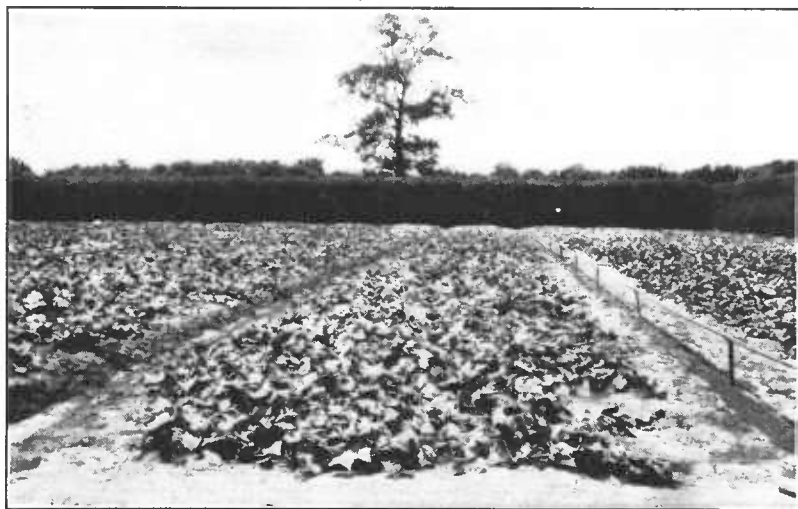


FIGURE 7.—Frame-grown cucumbers in the Norfolk, Va., district. Photographed in the same location on June 14, 30 days later than those shown in figure 6. Note the windbreak of California privet growing to a height of 12 or 14 feet.

POLLINATION OF CUCUMBERS

Pollination, or the setting of fruit, on cucumber vines is dependent upon some outside agency such as bees. Two kinds of flowers are found on every fruiting cucumber plant—the male ones (fig. 8), which supply the pollen, and the female ones (fig. 9), which produce the cucumbers. Both can be readily distinguished, as the female flower is borne on the outer end of the little cucumber. Generally, the male flowers appear in great abundance in advance of the female flowers, which leads to the erroneous notion that the cucumbers are failing to set fruit. Later, the female flowers appear, and fruit is formed. Cucumbers grown in the field are pollinated by either tame or wild bees from the neighborhood. Under favorable conditions, cucumbers grown in frames may be pollinated by natural agencies, but the sash growers of the Norfolk district provide stands of bees near their frames when the cucumbers are setting, in order to

insure perfect pollination. Without proper pollination the cucumbers are deformed, or at least a considerable percentage of nubbins are produced. In localities where bees are scarce it is advisable for the growers of cucumbers in fields to keep bees, in order to insure pollination.

CULTIVATION OF THE FIELD CROP

Cucumbers should be cultivated from the time the plants break through the ground, keeping the soil loose, mellow, and free from weeds until the spread of the vines makes further working impracticable. At first the cultivation may be fairly close to the hills and reasonably deep, but later after the roots begin to spread the cultivators should be run farther from the plants. It should be borne in mind that normally a cucumber is a comparatively shallow-rooted plant and that the roots often extend beyond the tips of the vines. It is therefore essential that, after the vines begin to run freely, cultivation should be relatively shallow and not too near the hills. Where the hills are carefully checked, cultivation can be carried on

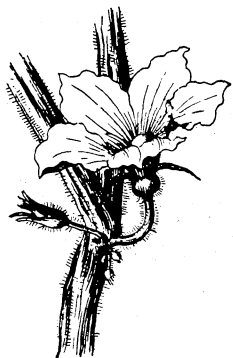


FIGURE 8.—The male or staminate flower of cucumber.



FIGURE 9.—The female or pistillate flower of cucumber.

in both directions during the early part of the season. Weeders, one-horse cultivators, and riding cultivators are employed for working the crop. The vines are frequently turned back and the soil cultivated to a depth of about 2 inches even after the vines have made considerable growth. Hand-hoeing will be necessary early in the season while the plants are small. The thinning of the plants in the hills is usually performed during the first and second hoeings. Light side dressings of nitrate of soda and of high-grade complete fertilizers are often applied just ahead of the third hand-hoeing and again during the final cultivation, the fertilizer being broadcast along the rows and worked into the soil by the cultivator.

After the vines cover the ground no further cultivation can be given, but it is sometimes necessary to go through and pull out weeds that are gaining a foothold. The vines of about every seventh row are usually turned back to form a space through which the sprayer can be driven. These spaces later may be used as roads when it comes to gathering the crop. In turning the vines a stick somewhat like an ordinary hoe handle is used.

IRRIGATION OF THE FIELD CROP

Cucumbers are grown under irrigation in the western irrigated districts, but the greater part of the commercial crop of the Eastern and Southern States is produced without irrigation. There are times, however, throughout the region of natural rainfall when irrigation would prove a decided advantage and greatly prolong the picking season. During periods of drought, when the field-grown cucumber crop is suffering because of lack of moisture and prices of good stock are high, irrigation will frequently pay. Many growers are now planting at least a part of their acreage either under overhead irrigation or on land that is subirrigated. Although the question of cost is the determining factor, the tendency is more and more toward the provision of all necessary conditions for making a high-grade crop. The results obtained by the sash-cucumber growers are due largely to their ability to control moisture conditions, thus prolonging the picking season and at the same time keeping up the quality. Being shallow-rooted, the cucumber suffers readily either from the lack of moisture in the soil or from an excess of it. Overwatering should be avoided; short but rather frequent applications of water should be made. It naturally follows that the grower who has irrigation facilities will reap the benefits during the seasons of short crops and high prices.

INSECT ENEMIES ¹

STRIPED CUCUMBER BEETLE .

Of the insects that attack the cucumber crop, the striped cucumber beetle is the most troublesome. The first of these beetles emerge from their winter quarters in the late spring, and as the seedling cucumber plants break through the ground they are attacked. The beetle feeds upon the tender seed leaves and the stems. The latter are attacked below the surface of the soil where cracks in the soil offer means of entrance to the beetles. Prompt control measures are essential to protect the crop. A 3-percent nicotine dust applied directly to the hills of small cucumbers with a box duster or with a bellows duster equipped with a cone nozzle is fairly effective, 15 to 20 pounds being required to cover an acre. When cucumbers are planted in rows, from 30 to 35 pounds of the dust will be required to the acre. To be effective the dust must be applied when the air temperature is above 70° F. and when the foliage of the plant is dry. This temperature factor precludes the use of nicotine dust in some sections. The first application is made at the first appearance of the beetles, this being followed by as many treatments as may be necessary to prevent injury.

A 3-percent nicotine dust may be prepared by adding 1 pound of nicotine sulphate (containing 40 percent of actual nicotine) to each 12½ pounds of hydrated lime and rolling for 15 or 20 minutes in a closed can or barrel containing one-half pound of stones or pebbles to each pound of dust. Nicotine dust may be purchased already prepared. Consult your county agent for information as to where it can be obtained. The dust should be kept in airtight containers until used, but it is best to mix it only as needed. Figure 10 shows a bellows-

¹ Prepared in the Division of Truck Crop and Garden Insect Investigations, Bureau of Entomology and Plant Quarantine. For further information on the control of insects injurious to the cucumber crop, write to the Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture, Washington, D. C.

type duster equipped with a cone nozzle, and figure 11 shows a box duster, both of which are useful in the control of the striped cucumber beetle.

In operating the bellows duster, the cone nozzle is placed over the hill of plants, the handle of the duster is given one stroke, and the cone is allowed to remain over the hill for a second or two, thus preventing the beetles from escaping while the dust is concentrated upon the hill.

The box duster is operated by dropping it over the hill with a sufficient jar to cause a small quantity of dust to sift through the burlap bag onto the plants. The box also is allowed to remain over the hill a second or two, and as the operator walks slowly along the row the duster is moved from one hill to the next with only a short pause in the stride of the operator.

Tightly covered cans containing a supply of the dust from which to replenish the small dusters should be placed at convenient points in the cucumber field. One man will cover from 8 to 10 acres a day with one of these hand dusters. Where the crop is sown in rows the dust may be applied directly to the plants with a hand duster equipped with the ordinary nozzle.

Calcium arsenate and land plaster or gypsum mixed at the rate of 1 part of the arsenical to 15 parts of land plaster is also a useful dust. This dust can be applied with a burlap sack or from a can the bottom of which has been perforated with small holes, the operation consisting simply in shaking the sack or can over the plants.

The plants should be kept fairly well covered with the dust from the time they appear



FIGURE 10.—Applying nicotine dust to cucumber hills by means of a dusting apparatus with a funnel attachment.

above ground until danger of insect attack is past.

Bordeaux mixture, with calcium arsenate added, drives away beetles and prevents injury to the leaves so treated.

Caution.—Sprays or dusts containing arsenicals or other poisonous chemicals of a stable nature should not be applied to the crop when fruits that will be marketed or eaten are on the plant, unless the residue can be removed by washing or stripping. All of these poisonous materials should be applied as sparingly as is consistent with the control of the insect. In dusting, every effort should be made to obtain a light, even coating and to avoid excess application such as frequently results from sprinkling the poison on the plant from a perforated can or sack. Early applications

will frequently make it unnecessary to apply control measures late in the development of the plant.

Results of work at various State experiment stations have shown that a derris dust mixture containing 0.5 percent of rotenone with gypsum (land plaster) or talc as a diluent is an effective remedy when applied to the beetles gathered on the plants. This dust may be purchased already prepared, or it may be home-mixed by following the same general method as that described for mixing nicotine dust. To prepare a dust containing 0.5 percent of rotenone, use the following formula:

Derris (4-percent rotenone content)-----	12½ pounds
Talc (or other diluent)-	87½ pounds

Information regarding the purchase of derris and other insecticide materials may be obtained through local dealers in agricultural supplies, seedsmen, general stores, drug and department stores, or from the county agricultural agent, State agricultural experiment station, or State department of agriculture.

MELON APHID

Cucumbers are frequently attacked by the melon aphid, a small louselike insect which obtains its food by sucking the plant juices. It feeds mostly on the under side of the leaves and, when abundant, causes the leaves to curl, lose color, and finally die. These insects start in the early part of the season as small colonies on the under side of the leaves, and, unless checked, they soon spread over the entire field. They are also carriers of certain diseases from one plant to another.

Dusting the plants with 2-percent nicotine dust is perhaps the most effective method of controlling this pest. For best results the dust should be applied at the rate of 30 to 50 pounds per acre when there is no wind, when the air temperature is above 70° F., and when the plants are dry. Hand dusters may be used in applying the dust to small areas before the lice have spread to all parts of the field, but where the infestation has become general and the infested areas are large, power or traction dusters should be used. Direct the dust to the under side of the leaves.

Spraying with nicotine sulphate to control the lice on cucumber plants has been found effective, but it is more difficult to reach the



FIGURE 11.—Box duster for applying nicotine dust for the control of striped cucumber beetles.

under side of the leaves with a spray than with a dust (fig. 12). The spray solution is made as follows:

Nicotine sulphate (40-percent nicotine)-----	$\frac{3}{4}$ pint (or 6 fluid ounces).
Soap (laundry or fish-oil soap)-----	2 to 4 pounds.
Water-----	50 gallons.

For small quantities make as follows:

Nicotine sulphate (40-percent nicotine)-----	1 teaspoonful.
Soap (laundry or fish-oil soap)-----	1 ounce (1-inch cube).
Water-----	1 gallon.

SQUASH BORER

After cucumbers have made good growth, they are sometimes attacked by the squash borer, or squash-vine borer. This is the large white grub that bores into the stems, sometimes cutting them almost through, near the roots.

Treatment.—When the borers attack cucumbers it is almost impossible to kill them without killing the plants. It has been found



FIGURE 12.—A power sprayer thoroughly spraying seven rows at once in a Florida cucumber field.

at the New Jersey Agricultural Experiment Station that nicotine sulphate, 1 part in 100 parts of water, applied to the basal part of the vines, will reduce infestation. Four or more applications at weekly intervals, beginning late in June or early in July, may be required. They also reported that dusting with a derris and talc mixture containing 1 percent of rotenone, or with a derris, sulphur, and clay mixture (20-25-55) containing 1 percent of rotenone, will aid in reducing the damage done by this pest. To prepare the 1-percent derris dust mixture the formula appearing in the discussion under Striped Cucumber Beetle may be used. The quantity of derris dust should be increased to 25 pounds and the diluent decreased to 75 pounds to obtain a rotenone content of 1 percent. The dust should be applied thoroughly to the stems and the basal part of the vines late in June or early in July in the latitude of New Jersey. Three or more applications at 10-day intervals may be required.

Preventive measures.—The dead vines and old plants should be destroyed as soon as the crop is gathered. Harrow the garden lightly in the fall and plow deeply in the spring to keep the moths from coming out.

DISEASES ²

Cucumbers are subject to a number of diseases that may be avoided by planting on clean land, or the losses caused by them may be reduced by seed treatment, spraying, or other means. Bacterial wilt, mosaic, angular leaf spot, downy mildew, anthracnose, scab, and root knot are fairly common and sometimes serious diseases which the grower should learn to recognize and control. In the Northern States the most important cucumber diseases are bacterial wilt, mosaic, and anthracnose, and in certain localities and in moist, cool seasons, scab. Under southern conditions downy mildew, angular leaf spot, root knot, and bacterial wilt are generally the most common and severe.

Cucumbers should not be planted in or adjacent to land where diseased cucumber, muskmelon, or watermelon crops were grown the previous year, because the causal organisms of several of these diseases live over winter in the soil.

DAMPING-OFF

Damping-off of cucumber seedlings is characterized by a shriveling and water-soaking of the stems at the ground line that causes a sudden collapse and death of the young plants. This trouble is caused by various fungi that are common in the soil and is most severe during periods of cool, wet weather. Damping-off can usually be satisfactorily controlled by dusting the seed with red copper oxide dust just before planting. The dust is used at the rate of about 1 level teaspoonful of dust to 1 pound of seed. The dust and seed are shaken together in a closed container to insure thorough coating of the seed, and the excess dust is screened off. This treatment does not take the place of the 1–1,000 mercuric chloride treatment described on page 18 for the control of angular leafspot and other diseases. The best plan is to treat the seed with mercuric chloride some time before planting and then apply the red-copper oxide just before the seed is planted.

BACTERIAL WILT

Cucumbers as well as muskmelons often wilt suddenly and die without any visible reason. The bacterial wilt disease is generally the cause. The bacteria enter and clog the water vessels of the stem and roots, causing wilting. Death of the plant soon follows, and sometimes serious losses result. The bacteria do not live in the soil, but are carried over winter and spread in the field by insects, particularly the striped and 12-spotted cucumber beetles. The best way to prevent damage from wilt is to spray with 2–4–50 bordeaux mixture and calcium arsenate or dust with gypsum and calcium arsenate, already described in connection with the control of beetles. The pulling and burying or burning of wilted plants is also helpful early in the season.

² Prepared by W. W. Gilbert, senior pathologist, Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry.

MOSAIC

Mosaic, or "white pickle"; occurs on cucumbers in many localities throughout the country, frequently causing heavy losses. It is characterized by a dwarfing of the plants, mottling, yellowing, and wrinkling of the leaves, and warting, curling, and mottling of the fruits. Juice from affected plants produces the disease in healthy ones when inoculated into them by any agent. Mosaic attacks several wild plants or weeds, including the wild or bur cucumber, pokeweed, milkweed, groundcherry, and catnip. It overwinters in their roots or seed and is carried to cultivated crops in the spring by insects. Cucumber beetles and lice are the principal agents in carrying mosaic from wild hosts to the cucumber plants and of spreading it in the field. Where cucumbers are grown for pickling purposes, the pickers are also very important agents in spreading mosaic during the picking season. The thorough eradication of the wild host plants in and near the fields, combined with rigid insect-control measures, has proved very successful in controlling mosaic. The Shamrock cucumber originally developed by the Iowa Agricultural Experiment Station as a mosaic resistant variety possesses considerable resistance.

ANGULAR LEAF SPOT, DOWNY MILDEW, AND ANTHRACNOSE

Angular leaf spot, downy mildew, and anthracnose all cause their principal visible injury to the leaves, developing and spreading rapidly during moist, warm weather.

Angular leaf spot, a bacterial disease, overwinters both on the seed and in the soil. It is recognized by the small, angular, water-soaked, or tan-colored spots on the leaves. Seed treatment, in combination with crop rotation, has been found effective in avoiding infection from the seed and the soil. The seed should be treated for 5 minutes in a 1 to 1,000 mercuric chloride solution and then washed thoroughly in water. Spraying with 2-4-50 bordeaux mixture will also help to control the disease.

Downy mildew, due to a fungus, causes faint yellow spotting and rapid curling and dying of the leaves beginning about midseason. Spraying the cucumber vines with 2-4-50 bordeaux mixture is the best available method of control for the trouble and will materially check the development of all three diseases, often permitting the harvesting of a profitable crop.

Anthracnose, also caused by a fungus, produces light-brown roundish spots, one-fourth to one-half inch in diameter, on the leaves, and elongated sunken lesions on the stems. The best method of control is the same as that for angular leaf spot.

BORDEAUX SPRAYING FOR THE CONTROL OF LEAF DISEASES

Spraying with bordeaux mixture is a preventive rather than a cure for fungus and bacterial leaf diseases. Successful control is obtained only when the work is started early in the season before the diseases become established and when it is done carefully and thoroughly with a high-pressure pump, so that all parts of the plants are coated with a fine mist of the spray mixture. It is essential also that the bordeaux mixture should be properly made and applied at intervals sufficiently frequent to cover the new growth promptly.

A power sprayer being operated in a Florida cucumber field is shown in figure 12.

Where considerable acreage is involved, a power outfit for spraying should be used and a bordeaux mixing platform constructed. A convenient method is to erect a wooden platform large enough to hold at least six or eight barrels and high enough to permit the solutions to run by gravity from the mixing barrels into the sprayer tank, as shown in figure 13. The platform should be near an ample supply of water.

Stock solutions of copper sulphate (bluestone) and lime should be made in separate barrels, the usual strength being 1 pound to the gallon. To make up 100 gallons of 2-4-50 bordeaux mixture, place 4 gallons of bluestone stock solution in a 50-gallon barrel and fill it



FIGURE 13.—Spray-mixing platform of a type used by the Florida cucumber growers. Water for making the spray is pumped from a well to the tank by a gasoline engine located beneath the tank.

with water. Likewise, after thorough stirring, place 8 gallons of lime-stock solution in a second 50-gallon barrel and fill with water, and by means of pieces of hose connected to the bottoms of the barrels allow the two solutions to run together through an 18-mesh copper-wire strainer into the spray tank. Thorough mixing of the two dilute solutions gives the best bordeaux mixture. It should be used immediately, as it deteriorates with age.

A simplified method of making bordeaux mixture is being used to a considerable extent, apparently with good results, and it appeals to many growers because of the fact that no mixing platform is required and only enough barrels to hold the stock solution have to be provided, unless water storage is necessary. According to this method, to make 100 gallons of 2-4-50 bordeaux mixture, 8 gallons of stock solution of lime (or 8 pounds of hydrated lime) is put directly into the sprayer tank, which is then filled three-quarters full with water, and the agitator is run to mix it thoroughly. Then 4 gallons of copper-sulphate stock solution is added and the tank filled with water.

The first spray application should be made when the plants are small, before or just as soon as the very first signs of disease appear. Other spray applications should follow at intervals of 7 to 10 days in rainy weather and 10 days to 2 weeks in hot dry weather, until the harvest is completed. A similar schedule should be followed if dusting is used.

Dusting with copper-lime fungicidal dusts is being tested, in some instances with good results. Its principal advantage is its quicker and easier application. Its main drawbacks are the greater cost of material and, in some instances, reduced effectiveness in disease control. A dust composed of 20 parts dehydrated copper sulphate and 80 parts lime is usually most effective.

SCAB

Scab is another fungus disease which attacks the cucumber and is quite serious during moist, cool seasons in certain northern cucumber-growing sections. It is characterized by the presence of small water-soaked spots on leaves, stems, and fruits, on which drops of a milky, gummy material are found early in the morning. Later in the day these dry up, and cavities with a grayish-olive lining of fungus spores are formed. Crops should be rotated in order to avoid the disease, as the casual fungus lives over in the soil of affected fields. Too-thick planting should also be avoided.

ROOT KNOT

Root knot is caused by minute nematodes or eelworms which attack the roots of cucumbers and many other farm crops and produce swellings or galls. Dwarfing and death of the plants result, and yields are often much reduced. This trouble is frequently very serious in the sandy soils of the South but is rarely of importance in the North. Crop rotation and planting cucumbers only on land free from nematodes are the best methods of control now known.

GATHERING AND PACKING

Table cucumbers must be fresh and crisp when received by the consumer, and the trade prefers that they be of medium size, well formed, and of a dark-green color over at least two-thirds of their length. Too much stress cannot be placed upon the necessity for frequent gathering of the cucumbers and their prompt handling after they are gathered. Careful handling is also essential in order to avoid bruising. Cucumbers that are gathered after a rain or in the morning while the dew is on them are liable to be dirty and discolored. All sand or dirt should be either washed or brushed from the surface. Rubbing with a cloth to remove dirt is objectionable, as it removes the small spines and the frosty finish of the fresh cucumbers. The best method of washing cucumbers is to dump the field baskets into a deep tank of clean, cold water through which a fresh stream of water is kept running. Slight stirring of the cucumbers in the tank will usually remove all dirt, but in extreme cases soft brushes are used.

Sash-grown cucumbers are generally gathered every other day, the individual cucumbers being cut from the vines, placed in baskets, and carried or hauled on a low-wheeled wagon or on a small truck to the packing house, where they are washed in a tank of clean, cold water and then spread on a slatted table to drain.

The cucumbers are graded into fancy, choice, and culls. The first two grades are then packed carefully in 28-quart hampers, the cucumbers being laid flat and the top of the hamper faced.

The sash growers in the Norfolk district grade and pack according to rules adopted by the Norfolk Hothouse Growers' Association and have the pack inspected. An attractive cardboard cover which bears the association label and trade mark is placed on top of the cucumbers beneath the lid. The grower's number and the grade are stamped on each package.

Most sash-grown cucumbers are shipped in refrigerator cars, about 600 hampers constituting a earload. Only the fancy and choice are shipped; the culls are sold locally.

Field-grown cucumbers are gathered as often as necessary to prevent their becoming too large or overripe. During the height of the



FIGURE 14.—Cucumbers gathered in baskets and carried to the ends of the rows. (Photographed near Meggett, S. C.)

season this will require going over the vines every day; in fact, the gathering of the cucumbers becomes practically a continuous process. As the cucumbers are cut or clipped from the vines they are usually placed directly in hampers or in field baskets, in which they are transported either to the ends of the rows (fig. 14), where they are repacked, or to the packing house. The cucumbers are sometimes gathered in bags slung over the shoulders of the workers, but bags are not so satisfactory for handling the cucumbers in the field as are the 1-bushel baskets or hampers. Splint baskets and rough crates should not be used for gathering the crop, on account of injury to the tender surface of the cucumbers.

A stick with a crosspiece about 1 foot in length nailed to its end is frequently used for turning the vines to locate the cucumbers; it has the double advantage of saving the operator from excessive stooping and serving as a protection against poisonous snakes in localities where they are found.

In certain sections field-grown cucumbers are packed in the field, being graded either as they are gathered from the vines or, more often, at the ends of the rows or at a temporary packing shed located in the field. In some instances they are hauled to the shelter of a large tree (fig. 15), where the grading and packing are done. In a great many sections the cucumbers are hauled to a centralized packing shed, where they are washed, graded, and packed in a careful manner. Belt graders are sometimes used in the centralized packing house, but as a rule the cucumbers are simply graded by hand over tables and packed directly into the hampers. For low cost of handling, however, packing in the field is considered most desirable, although a better grade and pack can be secured in a central packing house.

The United States standard grades for slicing cucumbers as established by the Bureau of Agricultural Economics are now used by



FIGURE 15.—Packing cucumbers for the market under the shade of a giant live oak near Meggett, S. C.

many individual growers and growers' associations. These rules are modified or amended from time to time to suit changed conditions.

LOADING AND SHIPPING

Field-packed cucumbers are generally hauled to the shipping point and loaded directly into the cars. Where the packing is done in a central packing shed, located on a railroad siding, the hampers of cucumbers are loaded directly into cars as they are packed. In any event, the packages should be removed from the field as quickly as possible after being packed, to avoid exposure of their contents to sun and wind. Where the pickers do the grading it is customary to have one man follow behind each gang of pickers to fasten the lids upon the hampers and mark the grade on each package with a rubber stamp. To facilitate these operations, the nails, hatchet, stamp, and ink pad are carried in a tray having a convenient handle. As a rule the lids are distributed by a boy ahead of the man who does the "lidding."

The truck or wagon for hauling follows closely behind and loads the hampers within a short time after they are packed. When once upon the wagon or truck the cucumbers can be protected from the sun and wind by a canvas cover. Usually the distance to the loading point is short, making it unnecessary to cover the load during the trip; but where the crop is hauled direct from the field to market by truck it is essential that the load be well protected by such a cover.

Certain definite rules as laid down by the carriers are observed in loading the hampers of cucumbers in the cars. The main essential for good loading is that the hampers be so placed that they cannot shift in transit. The method of shipment, whether under refrigeration or merely under ventilation, will depend upon the time of the year and the distance to market. As a rule, when the weather is reasonably cool and the shipment will reach the market within 36 hours it is not necessary to ship under refrigeration, but during warm periods and for long hauls shipment in refrigerator cars with bunker icing is essential. Where the cucumbers are sold f. o. b. shipping point, the question of method of shipment is left to the buyer, but where the goods are consigned or sold on delivery the method of shipping should conform to the wishes of the commission house or buyer receiving them.

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